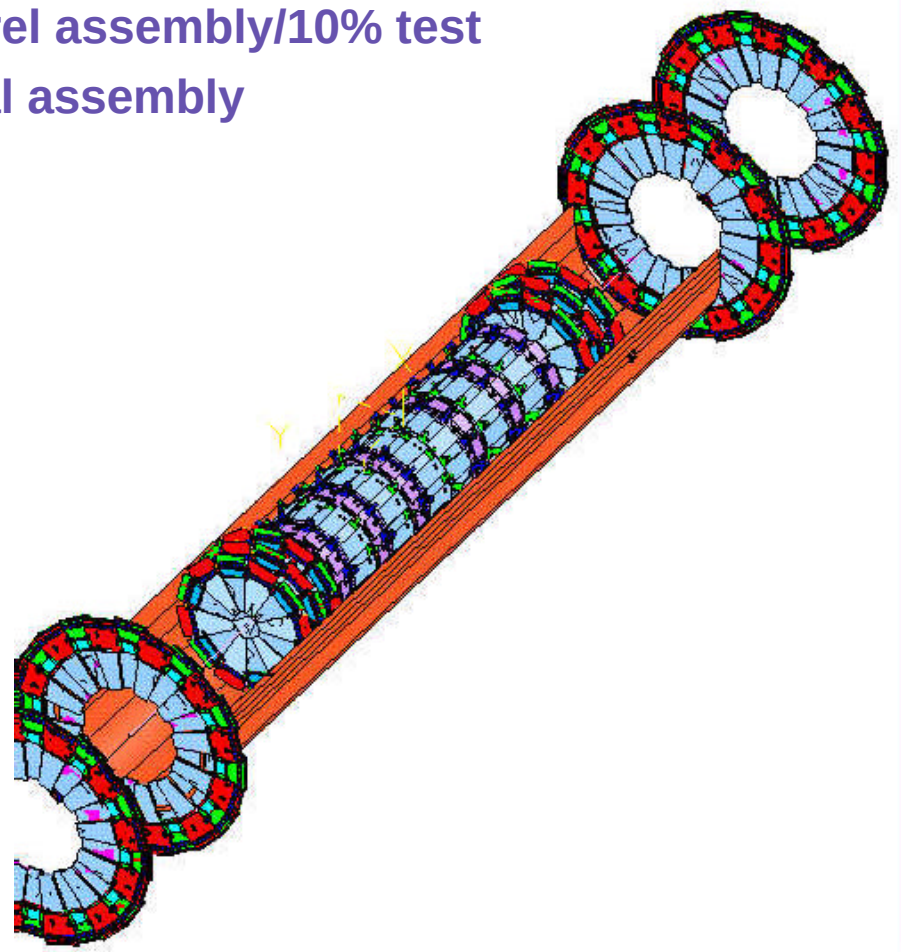
D0SMT Status

R. Lipton 6/17/99

- Outline
  - Tracker Design
  - Components
    - Detector procurement
    - HDIs and electronics
  - Production
    - Module production
    - Testing systems
  - Assembly
    - Barrel assembly/10% test
    - Final assembly

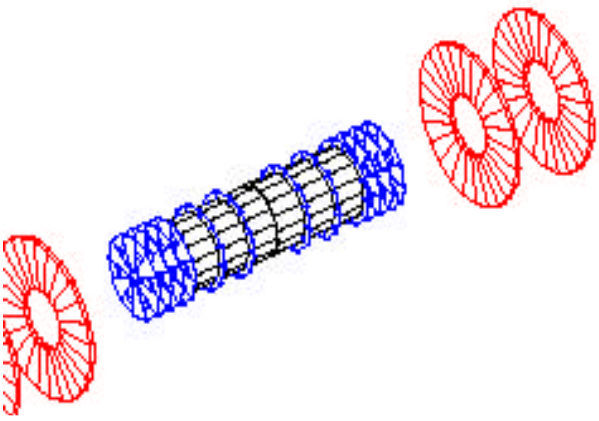


D0SMT Design

Major SMT Subsystems

5 Detector types:

- Single Sided Ladder (3 chip)
- Double Sided 2^{o} Ladder (9 chip)
- Double Sided 90^{o} Ladder (6 chip)
- H Disk
- F Disk



DØ	6 Barrels	F Disks	H Disks
Layers/planes	4	12	4
..\z	77 cm	48 cm	10 cm
Channels	387120	258000	147456
Modules	432	144	192
Readout Length	12 cm	7.5 cm	14.9 cm
Inner Radius	2.7 cm	2.6 cm	9.5 cm
Outer Radius	9.4 cm	10.5 cm	26 cm

Design - Barrel/Disk Module

Title:
barrel_f_disk_assy.eps
Creator:
ImageMagick
Preview:
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with a preview included in it.
Comment:
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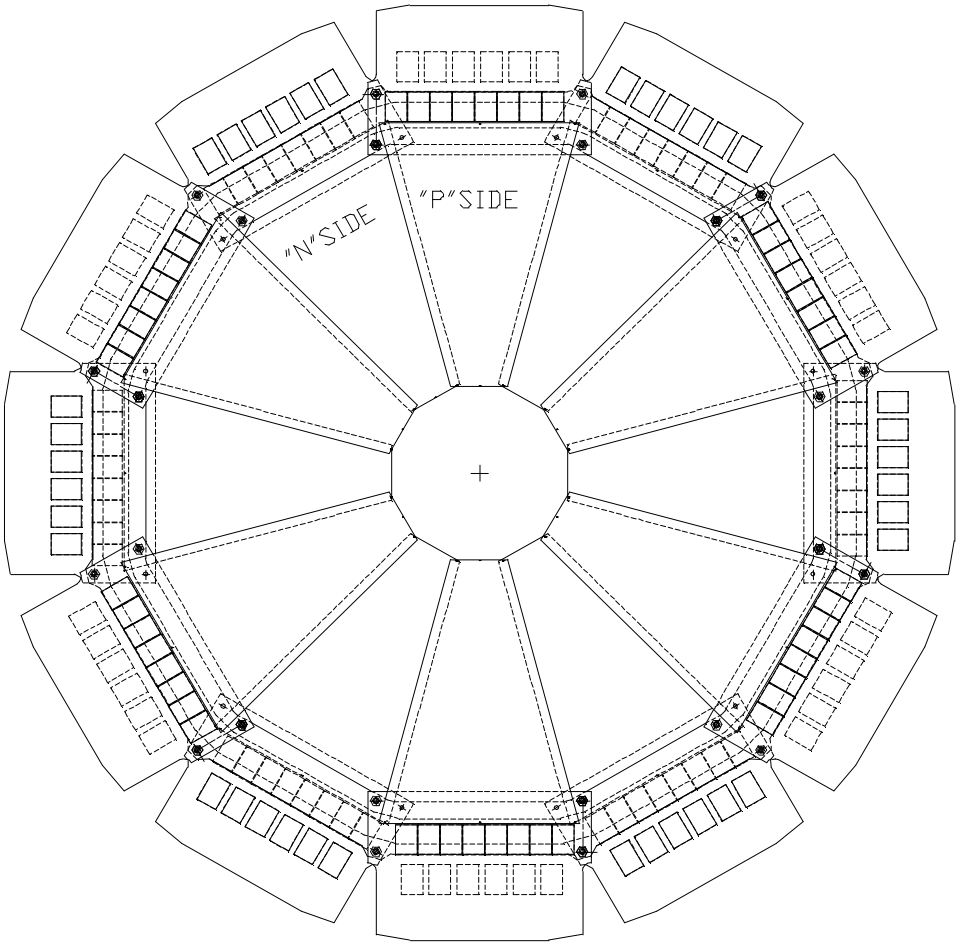
PostScript printer, but not to
other types of printers.

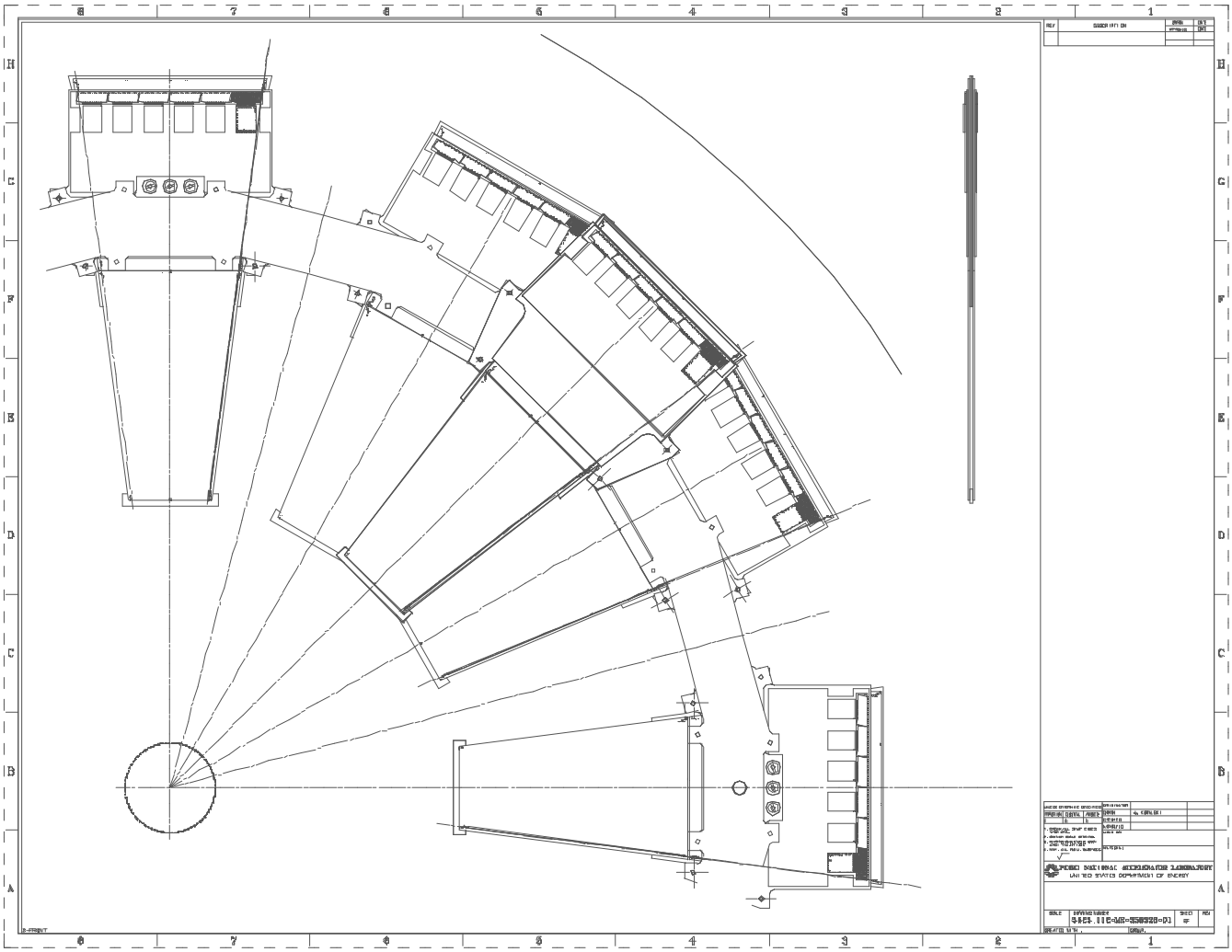
Design - F Disk



- *Silicon IR = 26 mm, OR = 105.27 mm at wedge centerline*
- *Readout mounts outboard of silicon, which allows disk to fit within a gap of 8 mm*
- *Wedges alternate between two surfaces of a central cooling/support channel (beryllium)*
- *Effective stereo angle = 30 degrees*
- *p-side Trace angle = -15^{o} with respect to wedge centerline Pitch = 50 μm*
- *n-side Trace angle = +15^{o} with respect to wedge centerline Pitch = 62.5 μm*

Design - H Disk

- *Silicon IR = 94.5 mm, OR = 236 mm at wedge centerline*
- *Readout mounts on outer silicon detector*
- *Wedges alternate between two surfaces of a central cooling/support channel*
- *Effective stereo angle = 15^{o}*



Components - Detectors

Type	Vendor	# Needed	# Received	% complete
3 Chip	Micron	144	>144	100%
6 Chip	Micron	144	12	8%
9 Chip	Micron/CSEM	432	244	56%
F disk	Micron/Eurisys	144	26	18%
H Disk	Elma (Russia)	384	330	86%

Delivery prospects:

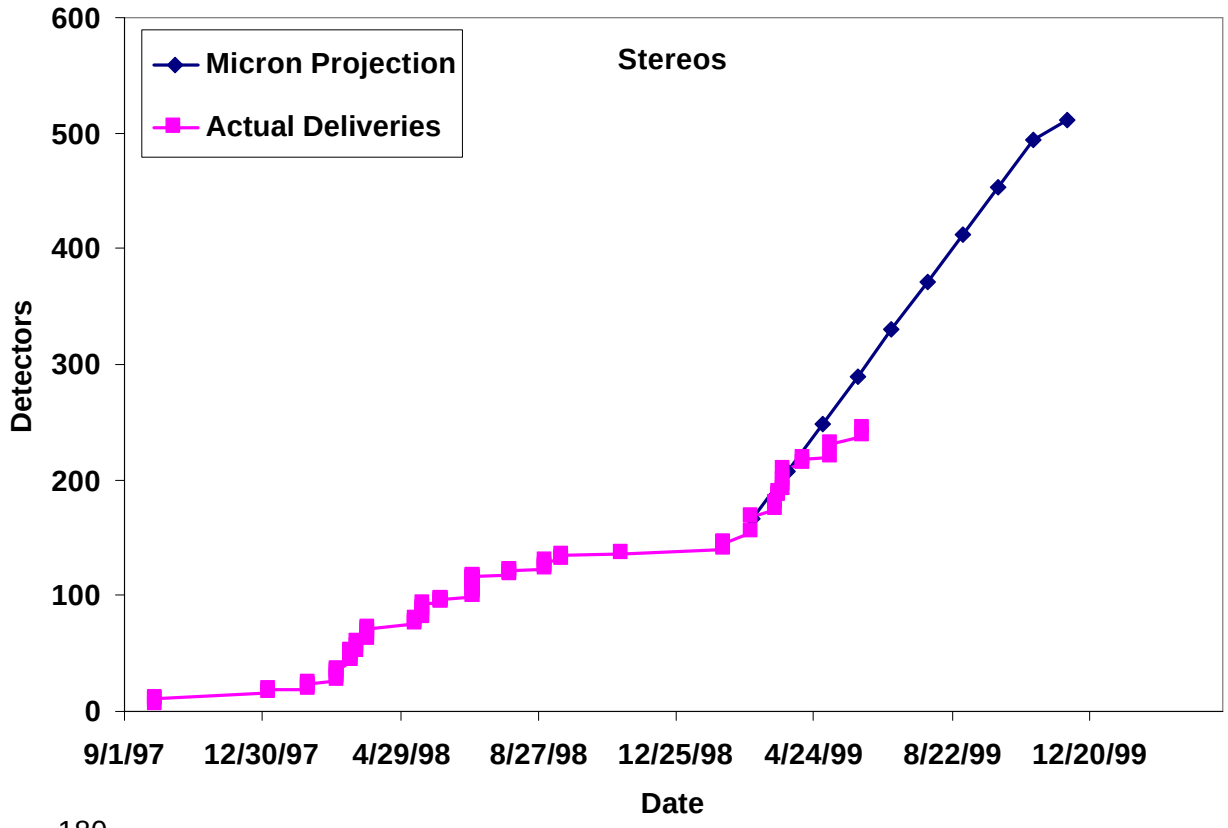
- 6 chip (DSDM) - Micron is now delivering good detectors. 38 good wafers are needed for 144 detectors. 117 wafers are in process. Expect 30 detectors/month.
- 9 Chip - Delivery has held steady for ~3 months should finish in November if there are no major interruptions
- F Disk - Currently our major concern, Micron has delivered <25 good detectors in 6 months -> add Eurisys order
- H disk - Delivery has held steady for ~8 months hope to finish order before factory shuts down on July-August

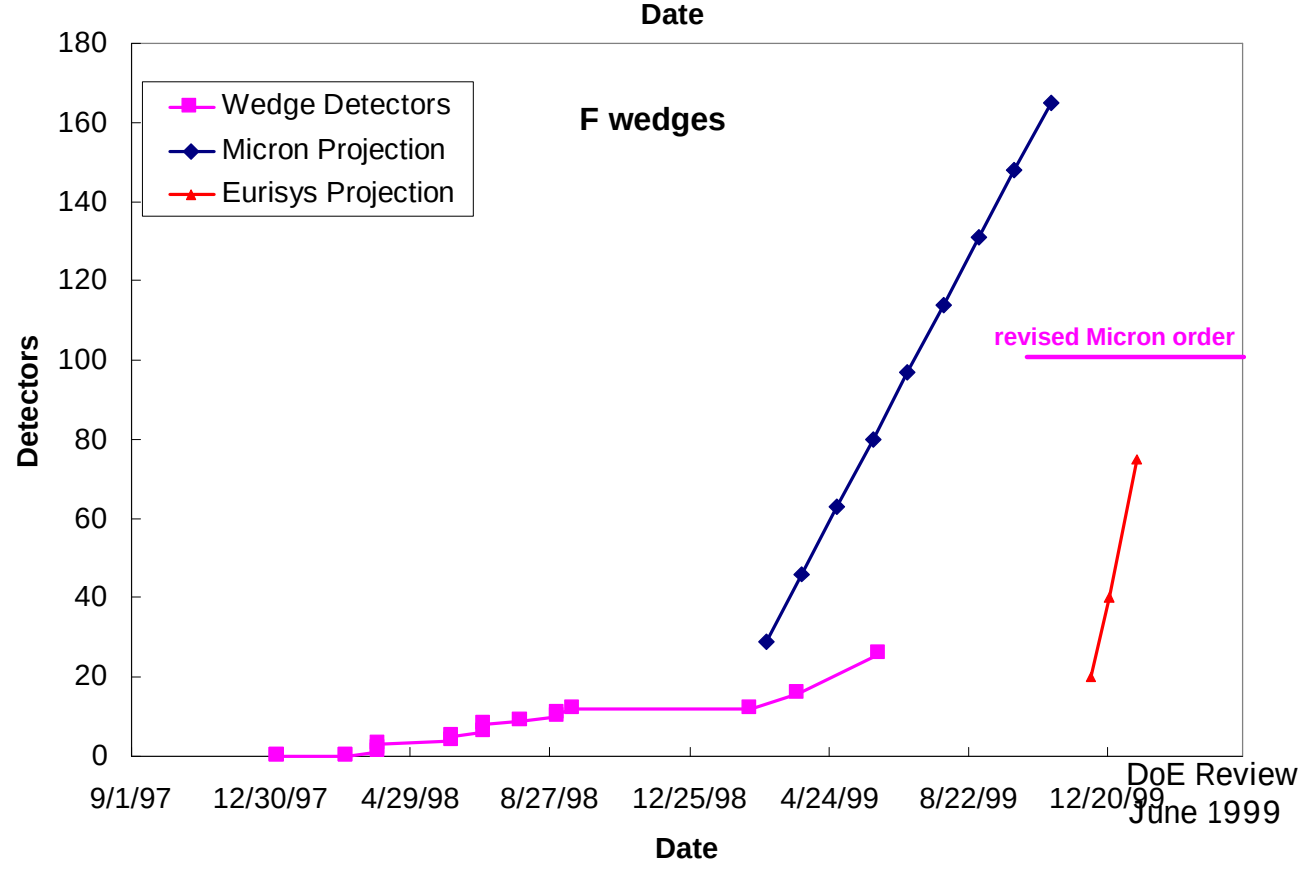
Detector Delivery - Micron

Detector delivery from Micron is a continuing concern. Actions taken:

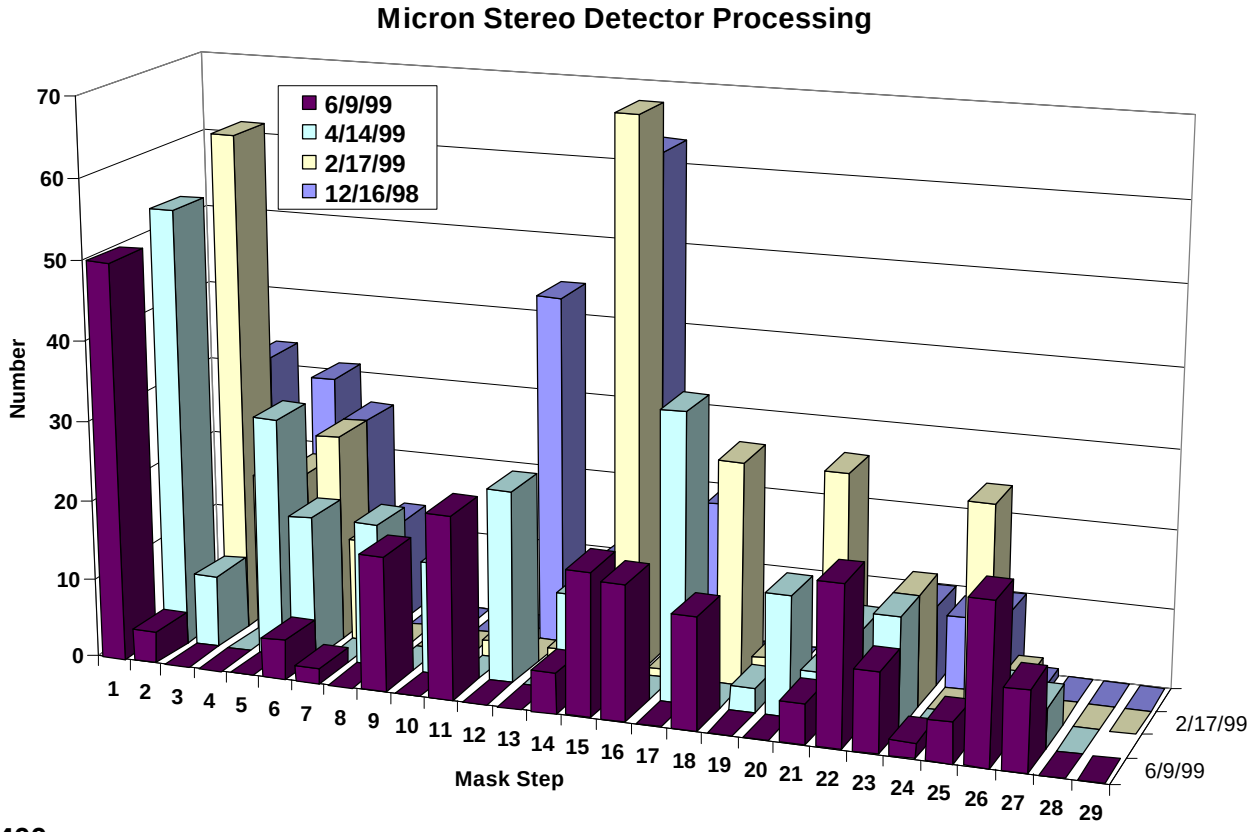
- D0 tech and Prague engineers at Micron since January - F and 9 chip detector testing now done by D0
- Supported Micron equipment purchases
- Loaned test equipment
- Lowered acceptance standards
  - 1%->2% failed capacitors
  - Increased leakage currents
  - loosened bias resistor specs
- Alternate Vendors
  - Prototype order for 9 chip to CSEM
  - F Disk order split, 43% Eurisys, 57 % Micron
- Incentives based on deliveries for CDF and D0 detectors
- Regular visits to the company

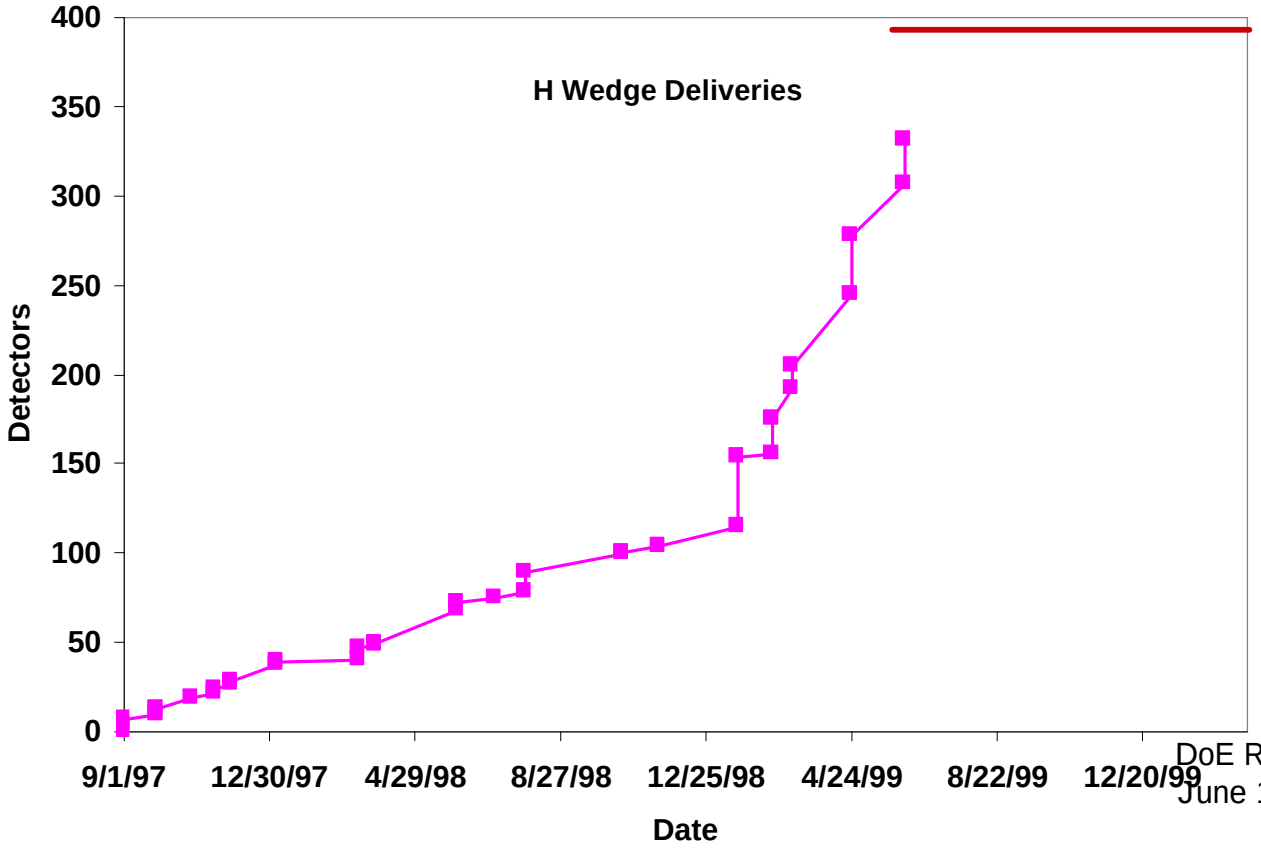
Detector Delivery - Micron



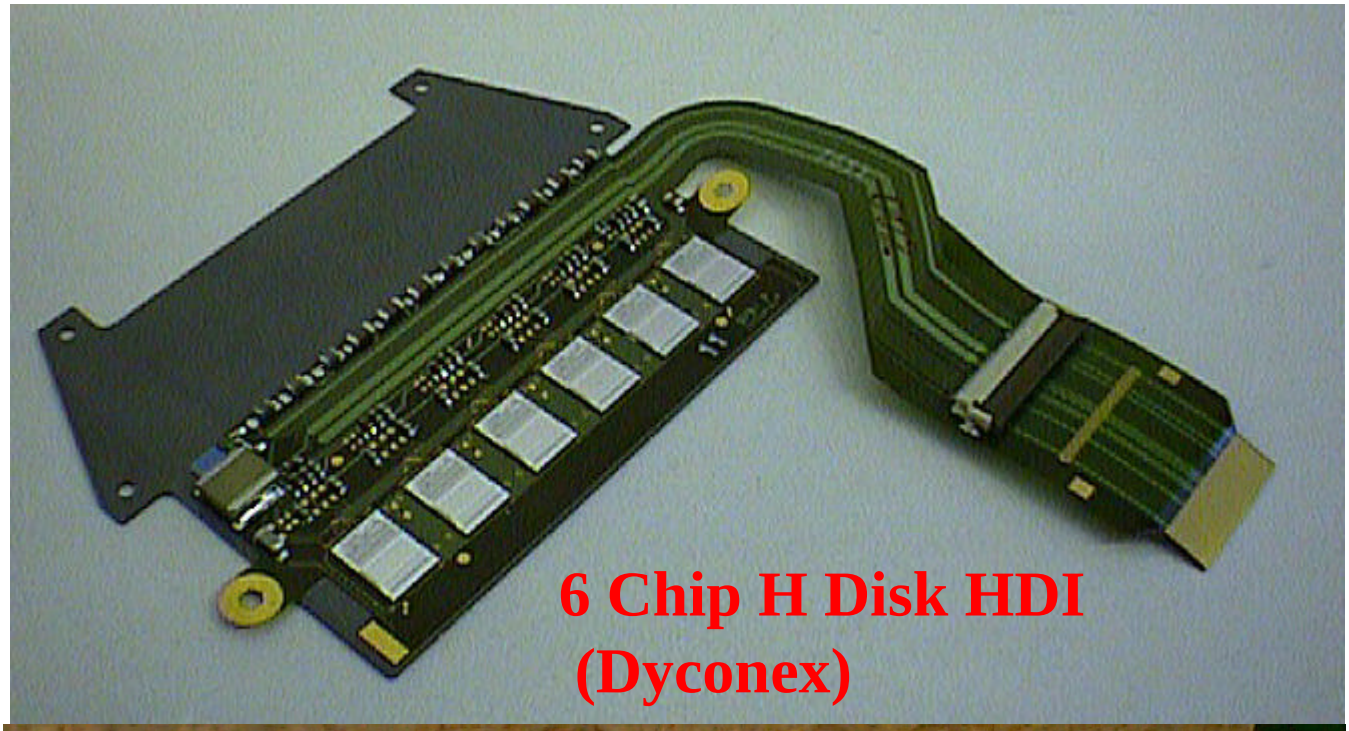


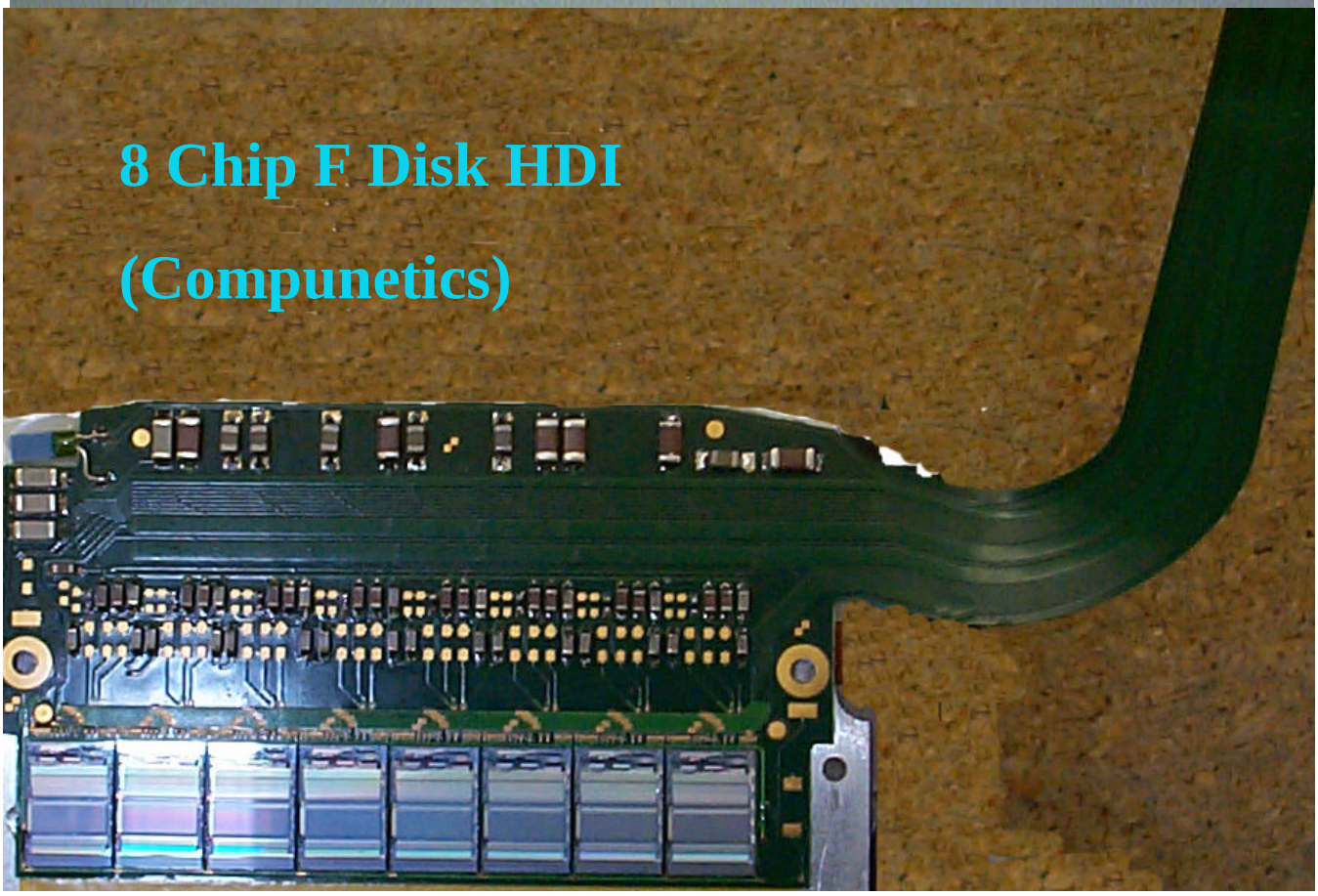
Detector Production





HDIs





HDI Status

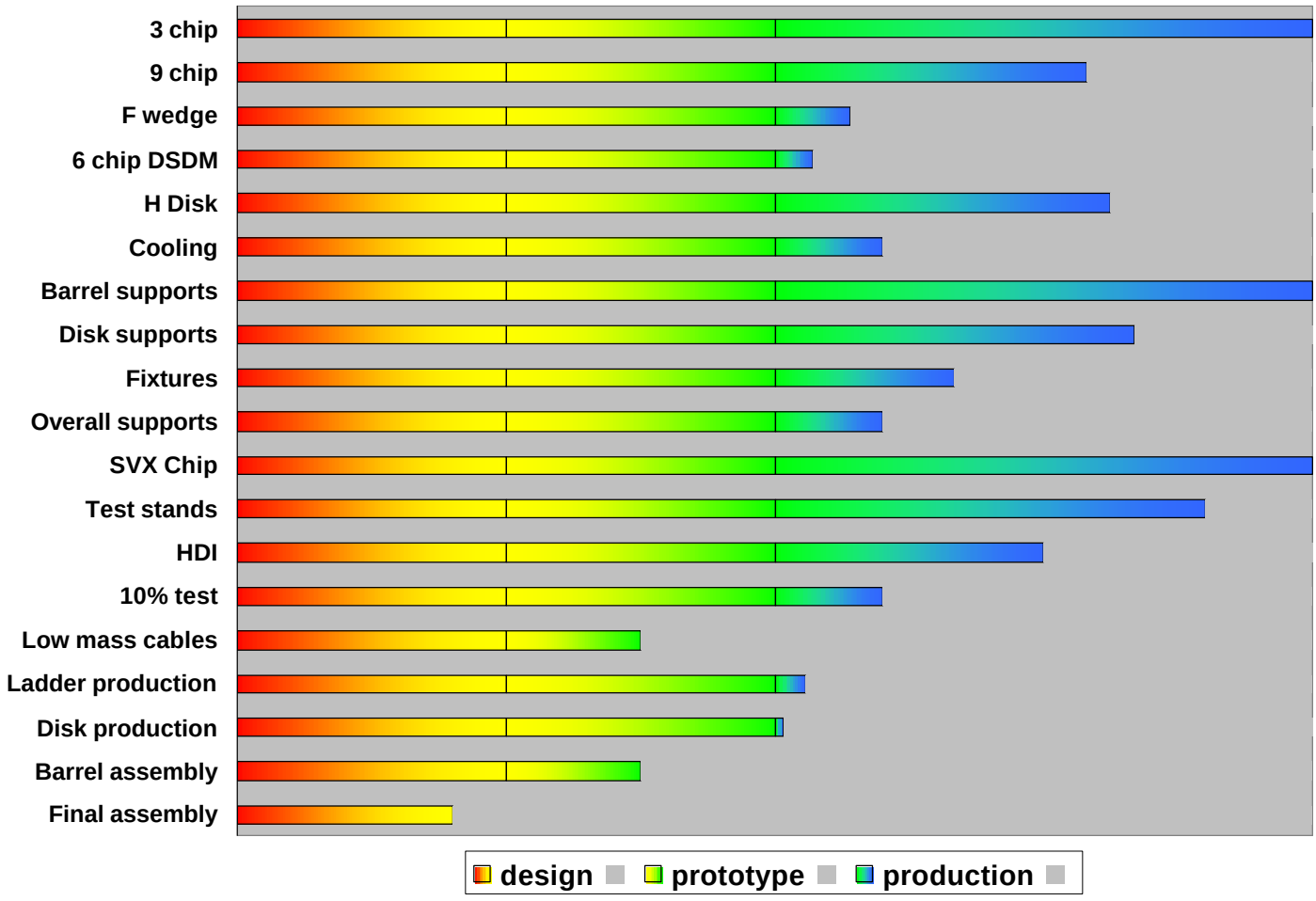
Type	# Needed	Company	%	Date Available
3-chip short	48	Dyconex	100%	Dec-98
3-chip long	24	LPC	100%	Jan-99
6-chip short	96	Compunetics	21%	Jul-99
6-chip long	48	Compunetics	0%	Jul-99
9-chip short	144	Speedy Circuits	100%	May-99
9-chip long	72	Dyconex	100%	Mar-99
6-chip F	144	Compunetics	17%	Jul-99
8-chip F	144	Compunetics	28%	Jul-99
6-chip H	192	Compunetics	65%	Jun-99

HDI Fabrication:

- Visual Inspection
- Lamination to Be substrate
- Component, chip mounting and wirebonding at Promex
- Testing and repair at UCI, UK, KU, FNAL

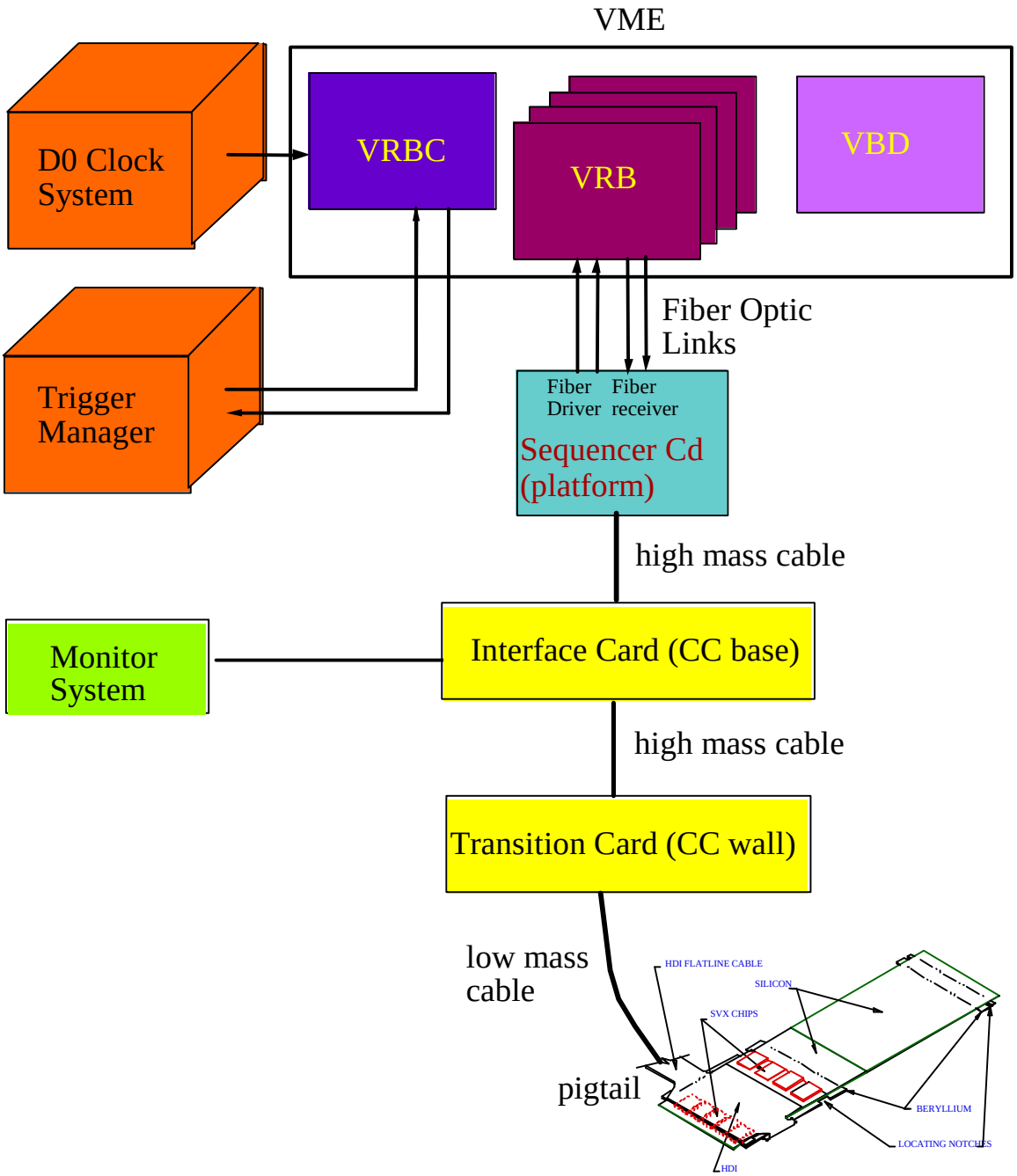
- Burn-in and encapsulation at FNAL

Overall Status



Components-Electronics

D0 Silicon Readout Scheme

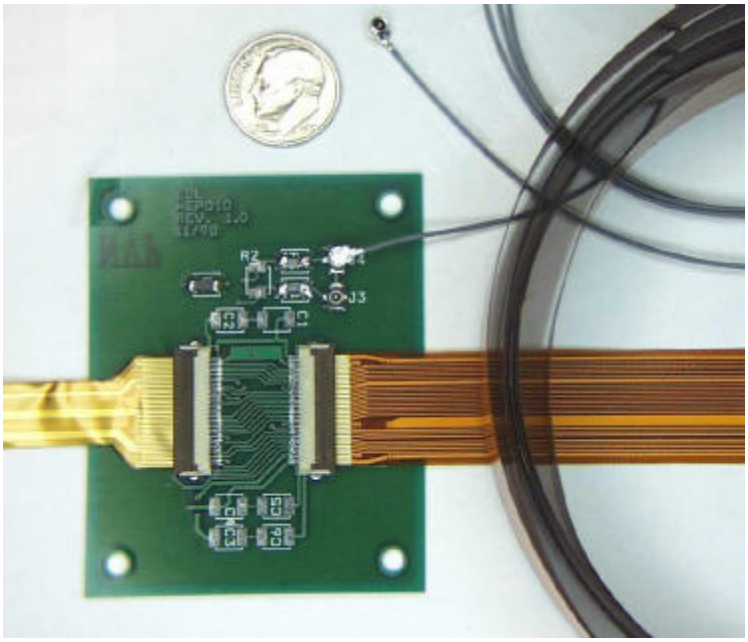


Electronics

- Full Crate readout test-prelude to VRB order completed 5/24
  - Full sequencer/VRB/Level 3 system
  - 12 mb/sec DAQ rate
  - >20,000 “equivalent” channels
  - error rate $<10^{-14}$
  - This test will turn into the basis for a single barrel “10%” test this summer.
- Low Mass Cable
  - 8’ flex cable with small trace pitch
  - Being made by Allied Signal KCP
  - First pass looks good but the dielectric was 2x too thin
- Interface Card
  - Detector monitoring, power conditioning, signal shaping, current monitoring … much more complex than originally thought
  - Located in crates at the base of the cryostat
  - 1553 interface, Bias supplies
  - Test stand version in hand and debugged - being used in burn-in stands

Electronics II

- Final System Shakedown
  - Detector ->
    - HDI ->
    - Low mass cable ->
    - Transition card->
    - High mass cable ->
    - Interface card ->
    - sequencer cable ->
    - Sequencer->
    - VRB
  - Only green items have been fully tested. We need to understand the signal characteristics for the full system.



Prototype cable elements being tested at KSU.

Production

This is a BIG job to be done in a short time

10 x larger than any previous silicon system

~ 1000 Ladders

~ 2 million wirebonds

12 test stands

Parallel production of 4 or 5 types

~ >12 technicians

~ 10-15 physicists

Production Organization

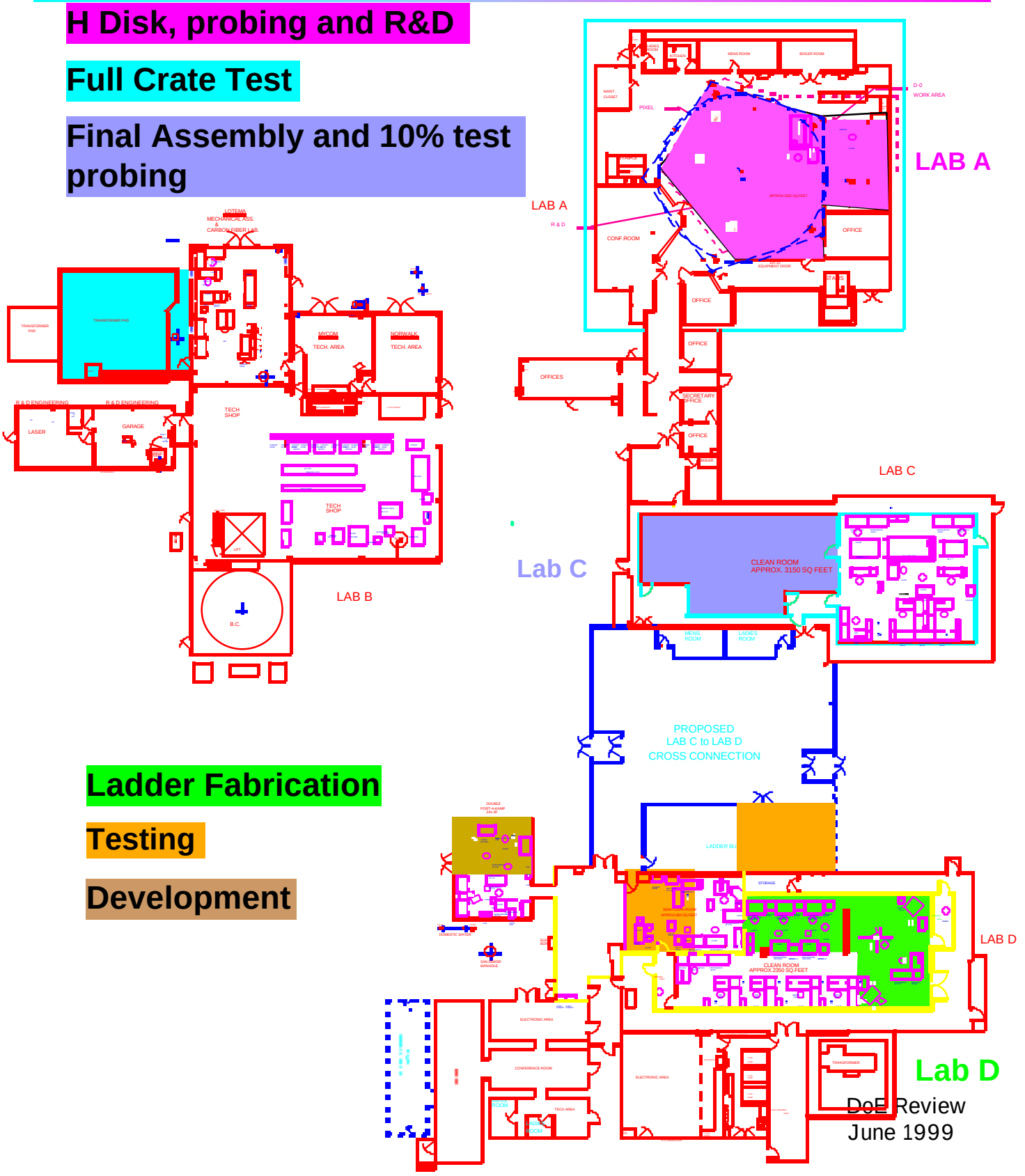
- Ladder Production - Physicist Shifts:
  - Production
  - Testing
  - Coordinator - Daily organization
  - "Expert"
- Production - 3-4 techs + 2 physicists (Lab D)
  - Detector alignment+gluing
  - in-process testing
  - wirebonding
  - pull testing and QC
  - CMM measurements
- Testing (Lab D-C crossover) 1-2 physicists
  - HDI functional test
  - HDI burn-in
  - Ladder functional test
    - ladder repair
  - Ladder LASER test
  - Ladder burn-in

SiDet

H Disk, probing and R&D

Full Crate Test

Final Assembly and 10% test probing



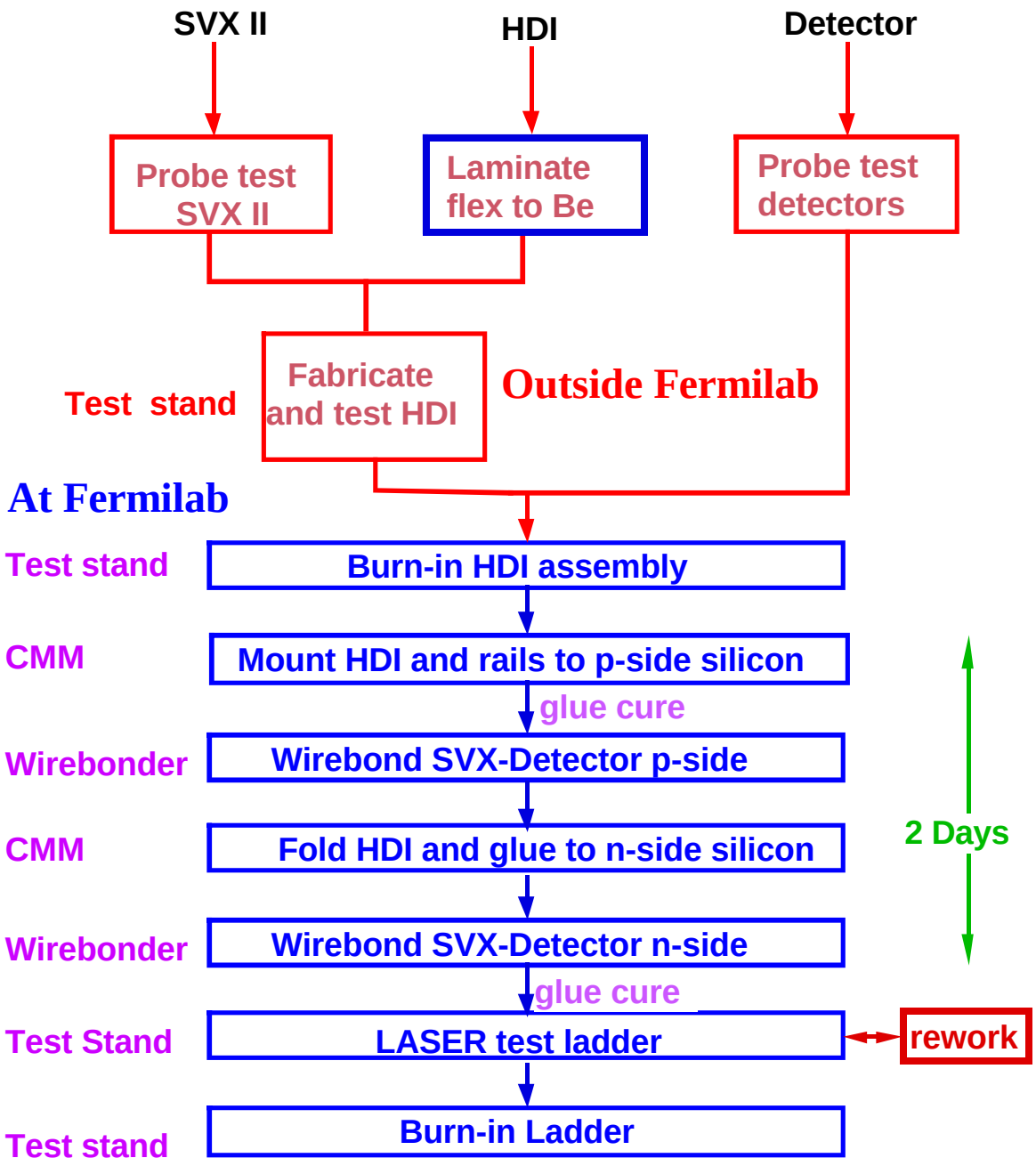
Ladder Fabrication

Testing

Development

DoE Review
June 1999

Ladder Fabrication



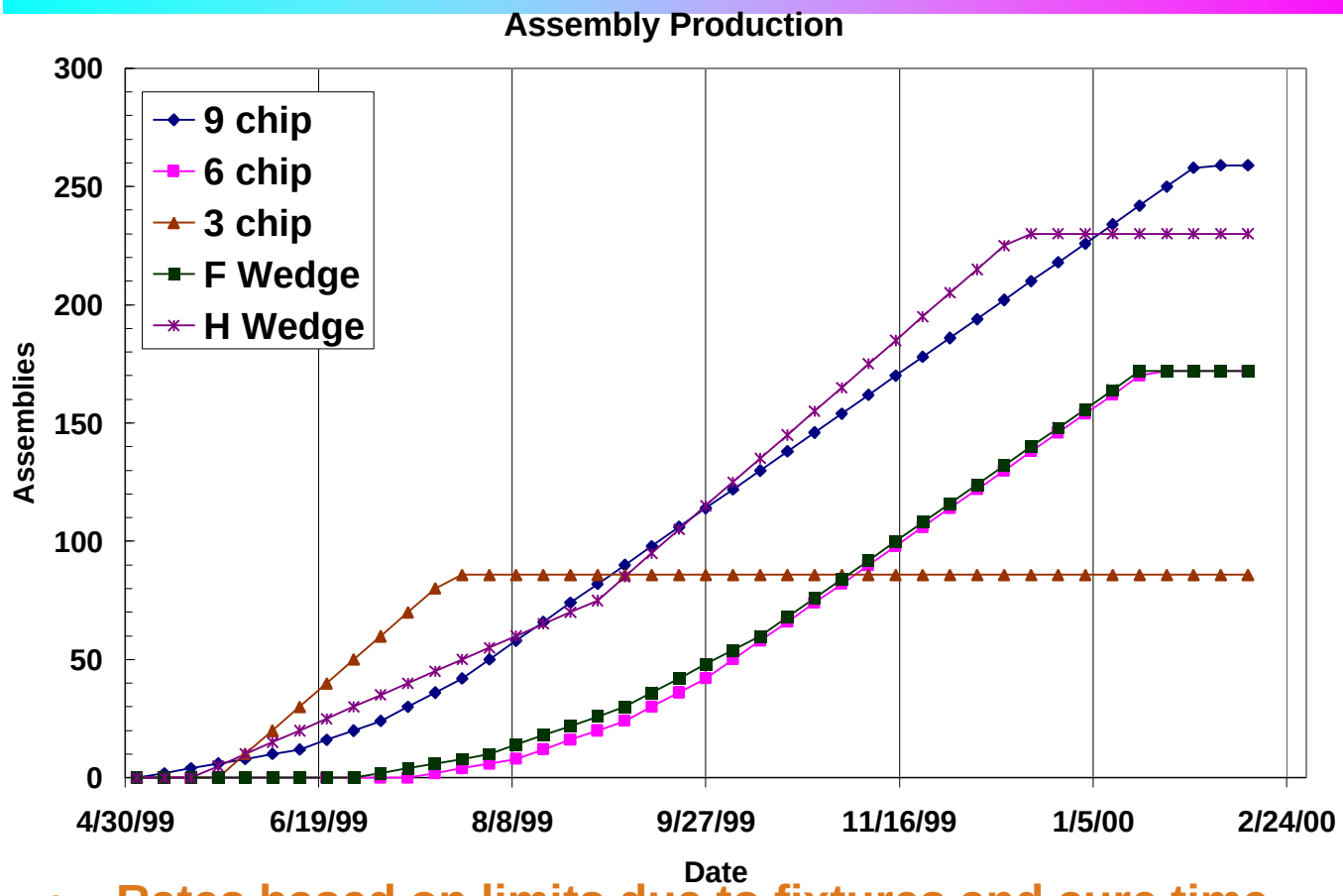
Ladder Fabrication

Step		Personnel	time (hrs)
HDI Lamination		tech	0.4
HDI burn-in 1		physicist	12.0
HDI encapsulation		tech & physicist	0.5
HDI burn-in 2		physicist	24.0
P-side assembly		tech & physicist	1
P-side wirebonding		tech & physicist	2
N-side assembly		tech & physicist	1.5
N-side bonding		tech & physicist	2.5
Ladder test		physicist	0.5
Ladder measurement		tech	0.25
Ladder repair		tech & physicist	1
Ladder burn-in		physicist	24
Ladder LASER test		physicist	0.5

Production "milestones"

- 5/1/99 - Begin production of 9 chip ladders (1 fixture)
  - 6/21/99 2 fixtures
  - 7/12/99 3 fixtures
  - 8/16/99 4 fixtures
- 5/24/99 - Begin production of H half- wedges (1 fixture)
  - 9/6/99 2 fixtures
- 5/31/99 - Begin production of 3 chip ladders (2 fixtures)
- 7/19/99 - Begin production of 6 chip ladders
  - 8/16/99 2 fixtures
  - 9/13/99 3 fixtures
  - 10/18/99 4 fixtures
- 7/5/99 - Begin production of F wedges
  - 8/9/99 - 2 fixtures
  - 8/30/99 - 3 fixtures
  - 10/4/99 - 4 fixtures
- 6/23/99 - "Dry assembly" of barrel
- 7/99 - 10% test electronics -> Lab C
- 8/99 - Full Barrel assembly
- 9/99 - Full F Disk assembly

Production Rate



- Rates based on limits due to fixtures and cure time with minimal contingency:
  - start times set by availability of electronics and fixtures
  - Slopes set by number of fixtures glue cure times
  - Ramp-up set by *skilled* tech manpower
- 20% Spares
- 2 shifts wirebonding
- Contingency
  - Weekends
  - Second gluing shift (it is possible to glue in the morning - second operation after 10- hrs)

Ladder/Wedge Production

Assembly Production Rate

Week	9 Chip	3 chip	H Wedge	F Wedge
6/7/99	2 + (1)	3	2	1
5/31/99	2 + (1)	4	1	
5/24/99	2 + (2)	3	1	
5/17/99	2 + (1)	1		
5/10/99	2			
5/3/99	2			
4/26/99	2			

- Items in () are mechanical assemblies for training and fixture qualification
- There were HDI failures in early production (before 5/15/99) due to poor wirebonds
  - All wirebonds in 9 chip HDIs are now being pull tested before they are used.
- Includes interruptions due to, HVAC problems in Lab D, Bonder repairs ...
- 9 chip and H wedge production are currently limited by HDI assembly at Promex

Test Stands

Special "stand alone" readout developed for production testing and development

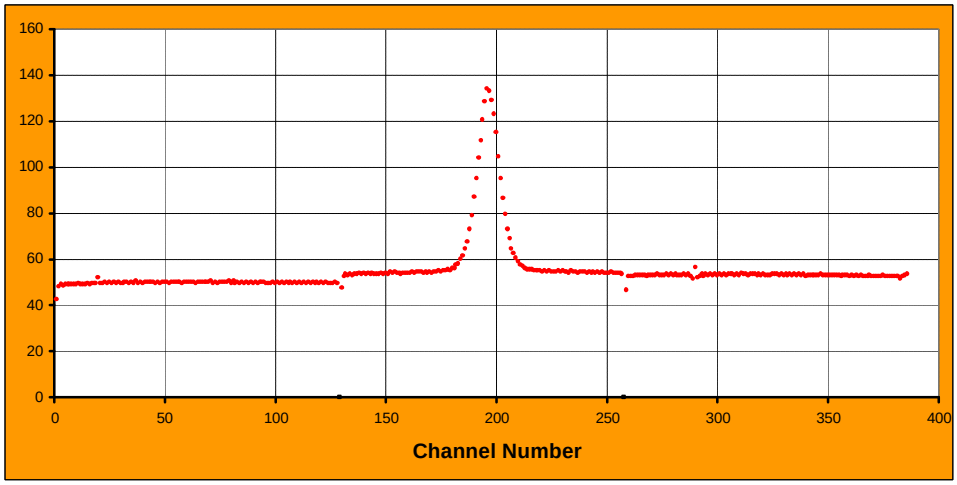
- single 6U VME board
- full speed/full functionality

Eleven functioning test stands based on the stand-alone sequencers

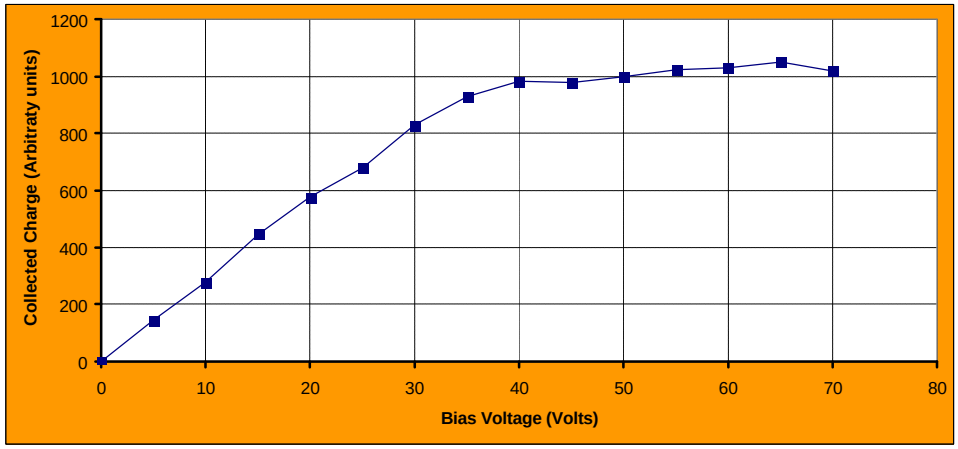
- Seven at SiDet, including 1 laser test stand
- Four at universities (BU, KSU, KU, UCI)

- Integral part of production process
  - HDI functional test
  - HDI burn-in
  - In-production functional test after each step
  - Ladder laser test
    - Functional test
    - VI curve
    - Depletion voltage plateau
    - Laser scan
  - Ladder burn-in

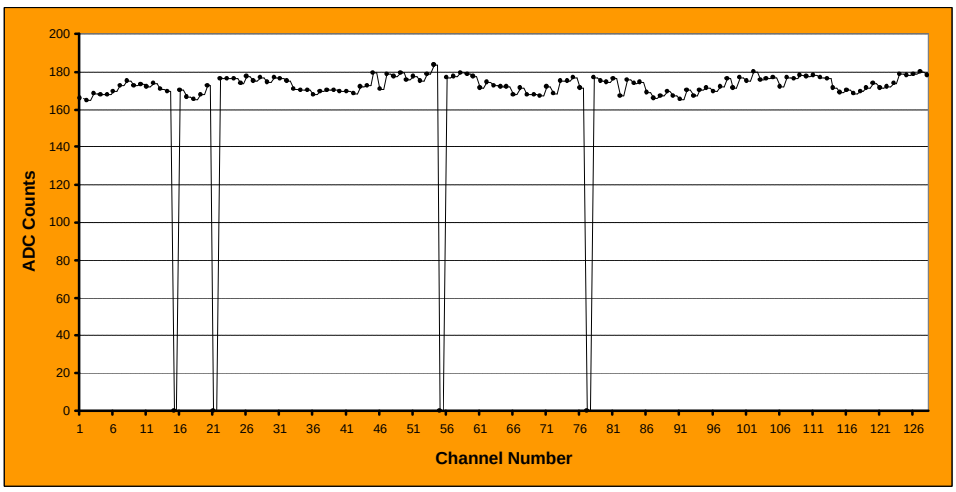
Laser Test Stand



LASER Signal



Plateau



Bad channel plot

Assembly and commissioning

- Assembly
  - 10% test - full barrel Aug-Sep
    - Understand techniques
    - Test readout and system noise
    - exercise software
  - Parallel construction/barrel assembly
    - Low mass cables, cooling manifolds installed and tested
  - Final measurements/ alignment in SiDet
  - Final Assembly
    - Transport silicon to lab 3
    - Install inside inner fiber cylinder
      - Measure with fiber CMM
      - Dress inner cables
    - Fit-up and remove H Disks
  - Move Tracker to D0
    - Final H disk installation
    - Cable and install services

Conclusions

- Much progress has been made
  - HDI problems resolved
  - Production started on 9 and 3 chip ladders, H wedges
  - 12 Test stands commissioned
  - Most parts in hand for production
- Issues remain
  - Detector delivery from Micron
    - wedges and 90 degree detectors
- Work to be completed
  - 10% test
  - Barrel assembly
  - Interface cards
  - Installation and cabling
- Production is now our focus
  - Production quality control - assemblies are fragile. Production is a BIG job.
  - Documentation and organization
- Goal: Completion by mid-February